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[OFFICIAL NOTICE.]

American Gas Light Association.

OFFICE AMERICAN GAS LIGHT ASSOCIATION,
142 CHAMBERS STREET, NEW YORK.

To the Members of the Association:

The Ninth Annual Meeting will be held in the city of Boston, Massachusetts, on the 19th, 20th and 21st days of October next. Headquarters during the meeting will be at the Hotel Brunswick. The meeting will be called to order at 11 A.M., Wednesday, 19th of October, in the Hall of the Institute of Technology, opposite the hotel.

Members intending to prepare papers are requested to notify the Secretary of the subject selected, so that the order of business may be arranged so as to give all an equal opportunity of being heard. Committees appointed at last annual meeting are respectfully reminded that they will be called upon for reports.

As every effort is being made to render this meeting full of interest, the Secretary trusts that each member will feel that some share of the responsibility for the success of this effort rests upon himself, and contribute, therefore, from the experiences and matured results of the past year to the general information. No subject bearing upon the vast interest represented in the Association is too trivial, or unworthy of careful investigation and report. Data of observations, results obtained in experimental or practical workings, old facts seen in new lights, or theories of management, all form a valuable basis upon which to found discussions or write papers. The object of these gatherings being to advance the interests of a common calling, it is binding upon all to add to the stock of information any fact that will throw more light upon it.

During the meeting the Association will be the guest of the New England Association of Gas Engineers, and the Boston Gas Light Company. The local Committee of Arrangements has provided in a complete manner for the social entertainment of the members. A sail on the harbor, a drive through the beautiful suburbs of Boston, and a dinner being prominent features in their programme.

Members wishing to reserve rooms, and those intending to bring ladies with them, are requested to communicate with M. S. Greenough, Esq., Chairman of Committee.

Blank applications for membership can be obtained at this office, where arrears of dues can also be paid until Sept. 30th.

WM. HENRY WHITE,
Secretary.

PROGRESS OF THE SCIENCE OF GAS MAKING.

In times like the present, when it is somewhat the fashion to appeal to science on all matters affecting the comfort, convenience, health and even the luxuries of daily life—it may not be unbecoming the gas maker to look to it that he is, in all respects, following a scientific procedure in order that he may be prepared to give a reason for the faith that is in him, and may be at all times able to repel the insinuations so often cast in a slurring, or, perhaps, in a patronizing way to the effect that "gas may do for a crude, ordinary light"; but that Science will develop a far better, more "scientific light" than we now have.

Far be it from us to put a straw in the way of such development. Let those who have time, genius, and money (either of their own or other peoples') to devote to such development, bend every energy for the accomplishment of the desired end. Whatever conduces to the health, happiness or wealth of the community is for good, and should be encouraged and supported by all.

But the point in which the gas maker should be most deeply interested is his own progress. It may be well to keep well informed as to the progress of others; but his energy should not be wholly expended in that direction, unless he is willing to sit down under the opprobrium of waste of energy.

It is with most sincere pleasure that we are able to bear testimony to the scientific progress that is being made in our own industry. If one looks back but a few years, how different was the status of the manufacture from

what it is to-day. The main characteristic of a gas works, as seen from the outside, used to be the conspicuous sign—

"Positively, no Admittance,"

and this sign, in many cases, was enforced as strictly against all knowledge, information, or new ideas, as it was against the people of the neighborhood, or the visit of some fellow-manager from another works. The inference that could have been drawn from that sign might have been that no progress was desired.

But better times have come. The formation and steady growth of Associations of gas makers, who meet from time to time for mutual consultation, information and improvement, has probably contributed more than anything else to the change. In Germany, France, England and America, there are well-established associations devoted to the advancement of the science of gas making. The oldest of these is but twenty-one years, and yet, we firmly believe, that the published reports of the papers and discussions of these various societies will, taken as an aggregate, compare most favorably with like reports of any other profession. It is but necessary to turn over the pages of these reports for a very few years to see how marked and how positive has been the progress in the application of true scientific principles to the conduct of our business. While there is no manufacture more delicate or more complex in its various details, it is a great wonder that it was ever established at all when we consider how little was known of its chemistry and its physics at the outset; and had it not been that the vast superiority of gas as an illuminating agent was so apparent that people were willing to pay high prices for it, in all probability the early rule of thumb management of the business would have ruined it. The philosopher spoke truly when he said, "Gas *is* a good thing; isn't it?"

The ever increasing cry for cheaper gas has been a spur in the flank of the profession which could not be resisted, and the demand has been met by more scientific, more careful, more rational procedure in the manufacture. Economies once unknown have been found and practiced, and we doubt not that the half is not yet discovered. By no means can one sit down and say we have done *all*. More must come, or science is false. Look at the heat wasted in the bench, the costly waste of hand labor, the unnecessary expense attending the want of proper mechanical appliances for handling material, the small value derived from (what ought to be a mine of wealth) the tar well and the ammoniacal liquor tank, and these alone will give opportunity for future economy, future improvement, and future progress, practical, scientific and financial alike.

We are approaching the time for the meeting, in Boston, of our American Gas Light Association. The Secretary has sent his appeal to the members to prepare themselves. We trust we may be pardoned if we most urgently press upon every member to do what he can to contribute some testimony that will show we have made a marked progress during the year. There are many things, in embryo, as it were, ideas not yet fully put in practice, and others that have been well worked out and shown to be successful—let the record be made so that the proceedings of our Association in Boston next October shall be second to none at home or abroad.

Darkness for Half an Hour.

The Brush electric lamps on Broadway between Fourteenth and Thirty-fourth streets, were again unlighted last night between 7:35 and 8 o'clock. Different explanations have been given from time to time to account for the failure of these lights. On one occasion it was stated that the continued wet weather then prevalent was the cause of the obscuration. Subsequently when the lamps again failed to burn, the Superintendent told a *Times* reporter that this was occasioned by the slipping of a band in the machinery. Last night, when interrogated as to the cause of the breaking down of the system of illumination, the person in charge at the central station in West Twenty-fifth street said there were several causes, but that he was too busy to speak about them. While the reporter was speaking the man in charge was approached by one of the private patrons of the Brush company, and was told that the light must be supplied with greater regularity or the use of it would be dispensed with altogether.—New York *Times*, Aug. 24th.

Ratio of Accidents and Production in Mines.

There is a certain ratio between the amount of ore raised in the mines and the number of men employed. In this country we do not keep these statistics accurately, but in England where they have government inspectors of mines whose duty it is to report all such things, they are kept carefully. The reports of these inspectors have just been published. By this statement it appears that, on the average, in 1880, in Great Britain and Ireland, there was at all the mines under the Coal Mines Regulation Act, one fatal accident amongst every 595 persons employed in and about the mines, and one death by accident amongst every 368 persons employed; also that 198,119 tons of mineral were got for each fatal accident, and 122,509 tons for each death by accident. In the preceding year (1879) the fatal accidents and deaths in the proportion to the number of persons employed were one accident and one death respectively amongst the numbers of 610 and 490, whilst in proportion to the tons of minerals raised the corresponding figures (1879) showed one accident and one death for the quantities of 185,890 tons, and 149,400 tons respectively, showing for the year 1880 an increase of production per fatal accident, and a decrease per life lost.

The summary of fatal accidents and lives lost in and about the mines shows that at the mines classed under the Coal Mines Regulation Act, in Great Britain and Ireland, the fatal accidents were 815 in number, and the deaths occasioned thereby (some of the accidents causing more than one death) amounted to 1,318; showing an increase upon the previous year of 33 in the number of fatal accidents, and of 345 in the number of lives lost.

In another summary it appears that in the aggregate, 484,933 persons were employed in and about the coal, fireclay, ironstone, and shale mines of Great Britain and Ireland, exclusive of those employed in and about mines which are classed under the Metaliferous Mines Regulation Act. The number and ages of the persons employed underground are distinguished from those employed above ground. Of the total number of persons employed, 391,381 were underground, and 93,522 (of whom 4,640 were females) above ground. Compared with the returns for the previous year an increase of 8,123 is shown in the number of persons employed.—*Sci. Press.*

Our Exchanges.

Injunction Against the Electric Light.—Akron, Ohio, August 2d.—This afternoon at 5 o'clock Judge S. H. Pitkin, as a taxpayer and citizen, through his attorneys, Judge R. P. Ranney, of Cleveland, and Judge S. W. McClure, of Akron, filed a petition enjoining the city from entering into a contract with the Brush Light Company for the further extension of the electric light in this city. The city of Akron and the Brush Light Company, of Cleveland, are defendants. The developments of the case will be watched with great interest as it is believed the gas company is at the bottom of the injunction.—*Cincinnati Commercial.*

Electric Fire.—Paris, August 25, 1881.—A fire, attributed to a defect in the fitting up of some incandescent lamps, broke out this morning in the reading room of the Electric Exhibition. The alarm was quickly given and the fire was extinguished before it had spread far. In attempting to tear out the wires with his hands a fireman was twice knocked down. A scientific commission, headed by MM. Dumoncel and Breguet, to-day made an examination of the connections of the various exhibitors and there is now no further danger to be feared.—New York *Herald.*

An Odd Plague.—St. Louis claims to have lately had a plague in the shape of flies. Nearly all the scientists in the town have investigated the insect, but no one has yet been able to tell to what genus or species it belongs. They throng about the electric lights at the hotels by millions, and on one Sunday night their immense numbers necessitated the extinguishing of those lights at the Lindell and Laclede. Chicago has as yet taken no steps towards counterbalancing this new attraction.

Rather Unreasonable.—A well-to-do Philadelphian was an earnest suitor for the heart and hand of a sprightly Camden widow. After a long courtship, which had failed to satisfy his expectations, he ventured, upon a certain occasion, when she seemed to be in a particularly good humor, to reproach her for her indifference. "Ah," she said, coquettishly, "I want to believe you, but how can I? You're a director in half a dozen gas companies."

Fuel Gas.—The Coney Island Fuel Gas and Light Company has been organized, and will commence the construction of works immediately, so as to be ready to supply to the hotels gas for cooking purposes at the opening of the next season.

Artesian Wells in the Coke Districts.

The Connellsville *Courier* says that coke manufacturers and furnace men within easy reach of the Youghiogheny are going to that stream for a permanent supply of water, others not so fortunately located are forced to adopt other plans. The Lemont Furnace Company and the Fayette Coke and Furnace Company have successfully surmounted the difficulty by putting down artesian wells. At the Oliphant furnace, operated by the latter company, water sufficient to fill a ten-inch pipe was obtained at a depth of two hundred feet, and at Lemont an inch and a-half stream was struck at the depth of nine hundred and twenty-five feet. The sand in this latter well smells strongly of petroleum, and a pint of oil was skimmed from a bucket full of water.

[A Graduating Thesis Read before the Stevens Institute of Technology.]

Gas Engines.

By Albert Spies, M.E.

(Continued from page 79.)

THE ATMOSPHERIC GAS ENGINE.

It was the aim of the inventor to overcome all the defects of the earlier gas engines—especially to avoid the shock which occurred at each explosion—and in his efforts he was governed by the following principles:

It is known that by the combustion of explosive mixtures heat is generated, producing either increase of volume or increase of pressure in the containing vessel. This increased pressure lasts as long as the products of combustion lose no heat; if, however, they are cooled by the surrounding atmosphere, or by some other agent, they contract. Since the pressure is to be utilized as a motive force, we may ask, "What time elapses between the heating and the cooling of the gases?" It is known that this time is of very short duration; and consequently if the heat generated by the combustion is not immediately utilized by allowing the heated gases to expand very rapidly, a large portion is lost by conduction and radiation through the cylinder walls. This loss of heat corresponds evidently to a loss of motive power. If, then, we have an engine constructed like the Lenoir engine, for example, with a connecting rod and crank, we have opposed to the force of the explosion in the cylinder not only the useful work, but the mass of the whole system. Such an engine, in order to utilize the whole explosive force, must work with an enormous velocity; but the moving parts can never take an acceleration corresponding to the intensity of the explosion, and therefore the heat which is not utilized will tend to heat the piston and cylinder. The inventor of the atmospheric gas engine on this account discarded the direct utilization of the explosive force, opposing to it but very slight resistance, but, after the expansion of the hot gases, made use of their contractile action as a source of power.

The engine consists essentially of a cast iron cylinder in which a metal piston moves air-tight up and down. At every explosion of the gas mixture this piston is shot up the cylinder, having but little more resistance opposed to it than its own weight and the resistance of the air. The mixture, after being fired, therefore expands very suddenly, and also cools rapidly, because the cylinder is furnished with a cold water jacket. On account of the sudden cooling of the gases, their tension falls far below the atmospheric pressure, and the piston is forced down by this latter pressure. It should here be mentioned that the cylinder is vertical and open at the upper end. The downward motion of the piston is that which is transferred to the engine. The piston rod is, properly speaking, a rack which gears with a small spur-wheel, the latter transmitting motion to the shaft. This spur-wheel is so constructed and arranged that, when the piston ascends, it turns loosely on the shaft; on the descent of the piston, however, it tightly clutches the shaft and forces it to participate in its motion.

The proper supply of gas is admitted to the cylinder by means of a slide valve. In the gas conductor there is a cock, by which the proportion of gas to air can be so regulated that the piston is shot up by the explosion to any desired distance, thus altering the performance of the engine at pleasure. Since the useful effect, however, is greatest for a certain height of rise of the piston, it is desirable so to regulate the force exerted that the throw of the piston may be always the same, and hence be independent of the performance of the engine in a given time. This is accomplished by making the number of strokes of the piston independent of the number of revolutions of the shaft, and for this purpose the exhaust pipe is provided with a cock, by adjusting which the products of combustion are allowed to escape more or less rapidly, which causes the piston to descend more or less rapidly. If this cock is wide open, the engine works with its maximum power.

The main differences of this gas engine from the earlier engines, then, are—

1. Intermittent action of the piston.
2. The special construction to transfer the downward motion of the piston to the flywheel.
3. Difference of the valve motion from other engines.
4. The regulation of the performance by changing the number of strokes of the piston for a constant number of revolutions of the flywheel.

Theory of the Atmospheric Gas Engine.

Let T_0 be the absolute temperature of the gas mixture, consisting of x cubic meters of air and 1 cubic meter of gas, and let T_1 be the absolute temperature after explosion.

Assuming, as before, that from the heat which every cubic meter of gas furnishes by its combustion $(1 - X)K$ heat units are withdrawn, then we have

$$T_1 - T_0 = \frac{1}{Cv} \times \frac{XK}{(1.225x + .535)}$$

Cv being the specific heat for constant volume, and being equal to

$$\frac{.1684x + .286}{x + .48}$$

The increase of density of D_1 we know to be

$$D_1 = \frac{x^2 + 1.48x + .48}{x^2 + 1.2667x + .3625}$$

and the pressure after firing is

$$p_1 = \frac{p_0 T_1}{D_1 T_0}$$

We may represent the law of variation during the ascent of the piston by the equation

$$pv^n = p_1 v_1^n$$

The external work performed by a gas volume when the law of variation of pressure and volume is represented by $p^m v^n = p_1^m v_1^n$ is

$$L = \frac{m}{n-m} p_1 v_1 - \frac{m}{n-m} p_1 v_1 (v_1^{(n-m)+m} \div v^{(n-m)+m})$$

and since we have assumed $m = 1$, we have

$$L = \frac{p_1 v_1}{n-1} - \frac{p_1 v_1}{n-1}(v_1^{n-1} \div v^{n-1})$$

v_1 being the least and v the greatest volume of the charge (volume before and after expansion respectively).

Denoting the piston area by F square meters, and the distance to which the piston is shot up by s meters, $e_1 s$ being the height of piston before ignition, then

$$\frac{v_1}{v} = \frac{Fe_1 s}{Fs} = e_1$$

and we have by substitution

$$L = \frac{1}{n-1} Fe_1 s p_1 (1 - e_1^{n-1})$$

Denoting the atmospheric pressure by p_0, we have

$$L = \frac{p_1}{p_0} - \frac{e_1}{n-1}(1 - e_1^{n-1}) Fsp_0$$

This work is required to impart motion to the piston, to overcome its friction, and to overcome the resistance of the air. To overcome this last resistance requires an amount of work equal to

$$Fsp_0(1 - e_1) \qquad (a)$$

Letting the piston friction equal R, then to overcome it requires the following work:

$$Rs(1 - e_1)$$

Putting $R = QFp_0$, this gives

$$Rs(1 - e_1) = QFp_0 s(1 - e_1) \qquad (b)$$

If the weight of the piston and rod = P, then in order to raise it to a height $(s - e_1 s) = s(1 - e_1)$ the work necessary is

$$Ps(1 - e_1)$$

or, if $P = ZFp_0$, then

$$Ps(1 - e_1) = ZFp_0 s(1 - e_1) \qquad (c)$$

The work of the expanding gases must then be equal to the sum of the three equations, *a*, *b*, and *c*. Therefore we have

$$\frac{p_1}{p_0} \frac{e_1}{n-1}(1 - e_1^{n-1}) Fsp_0 = Fsp_0[1 - e_1 + Q(1 - e_1) + Z(1 - e_1)]$$

which, by dropping Fsp_0, gives

$$\frac{p_1}{p_0} \frac{e_1}{n-1}(1 - e_1^{n-1}) = (1 + Q + Z)(1 - e_1)$$

Putting $p_1 \div p_0 = m$, we have

$$\frac{1 - e_1^{n-1}}{n-1} = \frac{(1 + Q + Z)(1 - e_1)}{me_1}$$

and since Q, Z, e_1, and m are regarded as known quantities, n may be determined.

Taking the case of a ½-horse power, then we have for F, e_1, s, P, and R the following values, as determined experimentally by Mr. Meidinger:

F = .01767 square meters.
e_1 = .114 meters.
s = .99 meters.
P = 21.8 kilogrammes.
R = 7 kilogrammes.
Therefore we have

$$P = ZFp_o = 21.8 \therefore Z = \frac{21.8}{.01767 \times 10334} = .119$$

$$R = QFp_o = 7 \therefore Q = \frac{7}{.01767 \times 10334} = .038$$

These values substituted in our last equation give

$$\frac{(1 + .038 + .119)(1 - .114)}{7.4 \times .114} = 1 - e_1^{n-1} \div n - 1 = 1.215$$

or, $1.215n - 2.215 = -e_1^{n-1} \therefore e_1^{n-1} + 1.215n = 2.215$

which equation gives for n the value 1.6, and therefore

$$pv^n = p_1v_1^n = pv^{1.6} = p_1v_1^{1.6}$$

is the law of variation of pressure and volume for this case. Knowing this, we can now determine the pressure and temperature at the end of the stroke of the piston. Designating this pressure and temperature by p and T respectively, we have

$$\frac{p}{p_1} = \frac{v_1^{1.6}}{v^{1.6}} \therefore p = p_1\frac{v_1^{1.6}}{v^{1.6}}$$

$$\frac{T}{T_1} = \frac{v_1^{1.6-1}}{v^{1.6-1}} = \frac{v_1^{.6}}{v^{.6}} \therefore T = T_1\frac{v_1^{.6}}{v^{.6}}$$

During the descent of the piston the useful work is performed by the engine, the descent being due to the weight of the piston, combined with the excess of the atmospheric pressure over the pressure beneath the piston. Some work is again expended in compressing the inclosed gases to the atmospheric pressure, and in driving them out of the cylinder through the exhaust port, and another part is required to overcome the piston friction. We must now calculate at what height of piston above the bottom of the cylinder the gaseous products are compressed to atmospheric pressure, the mechanical work necessary to compress them from p to p_o, and finally the theoretical delivery of the engine.

I. To calculate the height of piston above cylinder bottom at which the gaseous products are compressed to the atmospheric pressure p_o:

It is known that a volume of air (v) at a pressure p and temperature T weighs

$$G = \frac{pv}{RT}$$

but since in our case we have to deal, not with pure air, but with a mixture of air and carbonic acid, etc., R will have a different value. If we place for it R_1, then

$$G = \frac{p_1Fe_1s}{R_1T_1}$$

the pressure and temperature being p_1 and T_1 respectively. This weight must be the same at every position of the piston unless there is leakage. If, when the gaseous products are compressed to p_o (the pressure of the air), the temperature is T_2 and the volume Fe_2s, e_2s being the distance between the bottom of the cylinder and the piston, we have

$$G = \frac{p_oFe_2s}{R_1T_2}$$

From these two equations we have

$$\frac{p_1}{p_o} = \frac{e_2T_1}{e_1T_2} \therefore e_2 = \frac{p_1e_1T_2}{p_oT_1}$$

and therefore e_2s is the height above the cylinder bottom at which the products of combustion are compressed to atmospheric pressure. At this point of compression the exhaust valve is opened and allows the gas to escape.

II. To find the mechanical work necessary to compress the combustion products from p to p_o:

Let the law of variation of pressure and volume during the descent of the piston be represented by the equation

$$pv^{n_1} = p_ov_o^{n_1}$$

p and v being the pressure and volume at the highest position of the piston, and p_o and v_o being the pressure and volume at the height e_2s from the bottom of the cylinder. Then

$$\frac{p}{p_o} = \frac{v_o^{n_1}}{v^{n_1}} = \frac{(Fe_2s)^{n_1}}{(Fs)^{n_1}} = e_2^{n_1}$$

For the ascent of the piston we h

$$pv^1$$

Therefore

$$\frac{p}{p_1} = \frac{v_1^n}{v^n} = \text{---} e_1^n$$

Dividing the upper equation by the lower we have

$$e_2^{n_1} =$$

from which n_1 may be found. Then the mechanical work necessary to do the work of compression from the pressure p to p_o is given by the equation

$$L = \frac{1}{n_1 - 1}p_oFe_2s(1 - e_2^{n_1 - 1}) = Fsp_o\frac{e_2 - e_2^{n_1}}{n_1 - 1}$$

Furthermore, the air pressure and the weight of the piston must overcome the piston friction, which requires an amount of work represented by the equation

$$Rs(1 - e_2) = QFsp_o(1 - e_2)$$

Hence the work for both resistances is

$$Fsp_o(1 - e_2)Q + Fsp_o\frac{e_2 - e_2^{n_1}}{n_1 - 1}$$

The work furnished by the air pressure and piston weight is

$$Fsp_o[1 - e_2 + Z(1 - e_2)] = Fsp_o(1 + Z)(1 - e_2)$$

Subtracting the upper equation from the lower one, we obtain the following value for the theoretical delivery per revolution:

$$Fsp_o(1 + Z)(1 - e_2) - Fsp_o(1 - e_2)Q - Fsp_o\frac{e_2 - e_2^{n_1}}{n_1 - 1}$$

which equals

$$Fsp_o(1 + Z - Q)(1 - e_2) - Fspo_2\frac{e_2 - e_2^{n_1}}{n_1 - 1}$$

and if the engine makes u revolutions per minute, the delivery per second will be

$$Ls = \frac{u}{60}Fsp_o(1 + Z - Q)(1 - e_2) - \frac{u}{60}Fsp_o\frac{e_2 - e_2^{n_1}}{n_1 - 1}$$

meter kilogrammes. Dividing this by 75, we obtain the horse power developed. In the double-acting engine it often happens that at almost the end of the stroke the internal pressure becomes very low, by the condensation resulting from the combination of oxygen and hydrogen, and an expenditure of power is required to overcome the difference between the internal and external pressures. This negative work, which must be subtracted from the work developed during the period of expansion, exercises a visible influence on the performance of the engine, and the suppression of this cause of enfeebled action must necessarily be synonymous with an increase of useful effect.

At the Paris Exhibition, in 1867, several Otto & Langen engines were tested, and they were reported to consume about 38.1 cubic feet of gas per horse power per hour, this being a noteworthy advantage over the Lenoir and Hugon engine, these consuming about 70 and 74 cubic feet respectively.

In the year 1870 a number of tests of the atmospheric gas engine were made, a few of which are here given.

TRIAL OF AN OTTO & LANGEN ENGINE.

These trials were conducted by M. Tresca, the first one taking place March 27, 1870.

The dimensions of the engine were as follows:

Diameter of piston	.222 meters.
Maximum stroke	1.052 "
Height of water jacket..... ...	.965 "
Diameter "	.400 "

Pressure of gas, 30.5 mm.; duration of trial, 4 hours, the engine making during this time 20,563 revolutions.

The engine was provided with a brake, the length of whose arm was .75 meters, the weight at the extremity of the arm being 10 kilogrammes, and therefore the dynamometrical HP was

$$\frac{6.28 \times 20553 \times 10 + .75}{4 \times 3600 \times 75} = .896 \text{ HP.}$$

During the 4 hours of trial the gas consumption was 4070 liters, or 1017.5 liters per hour; and therefore the consumption per horse power per hour was

$$\frac{1017.5}{.896} = 1135.6 \text{ liters (about 39.4 cubic feet.)}$$

Estimating the gas consumption of the burners at 60 liters per hour, we get for the consumption for the work performed 1.135 — .060 = 1.075 cubic meters, 1135.6 liters being equal to 1.135 cubic meters, and 60 liters = .060 cubic meters. Then, assuming that the heat disengaged by the combustion of 1 cubic meter of gas was 6000 calories, we have for the total heat of combustion 1.075 × 6000 = 6450 calories. The quantity of cooling water around the cylinder was 110 liters, and was raised during the trial from 23° to 64° = 41° increase of temperature, or 110 × 41 = 4510 calories for four hours, which gives for one hour 1126 calories. Comparing this with the total heat expended, we find that the cooling water carries off about one-sixth of the heat produced; this value, however, being somewhat too low, since the water cools before its temperature is determined.

The engine was so regulated that at every revolution a volume of air and gas was admitted to the cylinder, this volume being

$$.145 \frac{HD^2}{4} = 5.61 \text{ liters, } (H = 3.1416),$$

where D is the diameter of the cylinder and .145 meters is the distance from the bottom of the cylinder to the piston at the moment of explosion. Since the total gas consumed was 4070 liters for four hours, and since 60 liters per hour were required for the burners, the engine alone consumed only 3830 liters. The number of revolutions during four hours being 20563, the volume of gas used per revolution was 3830 ÷ 20563 = .1862 liters. The volume of gas and air introduced at each stroke was 5.61 liters, and consequently the proportion of air in the mixture is given by the ratio 5.61 ÷ .1862 = 30.12. The work performed per calorie is

$$\frac{270{,}000 \times .896}{6450} = 37.5 \text{ meter kilogrammes.}$$

Trial II.—Gas pressure, 36 mm.; duration of trial, one hour; number of revolutions during one hour, 4917; length of arm of brake, .75 meters, and the applied weight was, as before, 10 kilogrammes. Dynamometrical horse power,

$$\frac{6.28 \times .75 \times 10 \times 4917}{3600 \times 75} = .857 \text{ HP.}$$

The gas consumption was 1085 liters, and the consumption of the burners was determined to be 65 liters per hour: then the total consumption per HP per hour = 1085 ÷ .857 = 1266 liters (about 44.68 cubic feet.) The gas consumption of the engine alone equals 1.266 — .065 = 1.201 cubic meters, and therefore the heat disengaged was about 7206 calories. The cooling water, amounting to 107 liters, was raised 9 degrees in temperature (from 33° to 42°), representing 9 × 107 = 963 calories; the ratio of the heat expended to the heat lost being 7206 ÷ 963 = 7.47. The work per calorie was

$$\frac{270{,}000 \times .857}{7206} = 32.1 \text{ meter kilogrammes.}$$

The volume of gas used per revolution was 1020 ÷ 4917 = .207 liters, and the proportion of air was 5.61 ÷ .207 = 27.1.

Trial III.—Gas pressure, 36 mm.; duration of trial, 30 minutes; number of revolutions during trial, 2446; length of brake arm, .75 meters, and applied weight 5 kilogrammes. Dynamometrical horse power

$$\frac{6.28 \times .75 \times 5 \times 2446}{1800 \times 75} = .426 \text{ HP.}$$

Total gas consumption during 30 minutes, 280 liters, or 560 liters per hour, and therefore the consumption per horse power per hour is 560 ÷ .426 = 1314.5 liters (46.4 cubic feet). The heat expended = 6000 × .506 = 3036 calories; heat absorbed by cooling water, 321 calories. Ratio of heat expended to heat lost, 3036 ÷ 321 = 9.4. Work performed per calorie expended

$$\frac{270{,}000 \times .426}{3036} = 37.8 \text{ meter kilogrammes.}$$

Gas consumed per revolution, 253 ÷ 2446 = .103 liters. Proportion of air to gas, 5.61 ÷ .103 = 54.46.

Trial IV.—Duration of trial, 30 minutes; number of revolutions, 2399. Gas pressure, brake arm, and applied weight were the same as in the previous trial. Dynamometrical horse power,

$$\frac{6.28 \times 5 \times .75 \times 2399}{1800 \times 75} = .418$$

The gas consumption during the trial was 280 liters, or 560 liters per hour; and consequently the consumption per horse power per hour was 560 ÷ .418 = 1339.7 liters (46 cubic feet, nearly). The heat expended was 6000 × .5088 = 3052.8 calories, and the heat absorbed by the cooling water was in this case not determined. The work per calorie was

$$\frac{270{,}000 \times .418}{3052.8} = 36.96 \text{ meter kilogrammes.}$$

Gas consumption per revolution, 280 ÷ 2399 = .116 liters. Proportion of air to gas, 5.61 ÷ .116 = 48.36.

Summing up these results we have the following table:

Summary.

No. of Trial.	Duration of Trial.	Velocity of Engine per Minute.	Work Developed.	Consumption of Gas per HP per Hr	Ratio of Heat Developed to Heat Lost.	Work per Calorie.	Proportion of Gas in 100 Volumes of Mixture.
						M. Kilos	
1	4 hours.	85.67	.896	299.79	6.149	37.5	3.32
2	1 hour.	81.95	.857	354.22	7.47	32.1	3.69
3	30 minutes.	81.53	.426	347.028	9.4	37.8	1.83
4	30 minutes.	79.96	.418	353.68	.....	36.96	2.06

The economy of fuel is an important feature of this engine, and must be attributed to the rapidity of working of the piston, allowing very little time for the radiation of the heat from the cylinder walls. This proves, in a measure, that high piston speed is a condition of economy in gas engines as well as in steam engines, or wherever the working fluid expands within a chamber whose sides are good conductors of heat.

THE BRAYTON GAS ENGINE.

This engine is similar in appearance to the steam engine, with this difference, that it is provided with a compressing pump and reservoir, for the purpose of compressing and retaining a quantity of combustible gases, mixed with a proper proportion of air, and at a pressure exceeding that which it is proposed to have exerted in the cylinder. The reservoir, then, has the same relation to this engine that the boiler has to the steam engine.

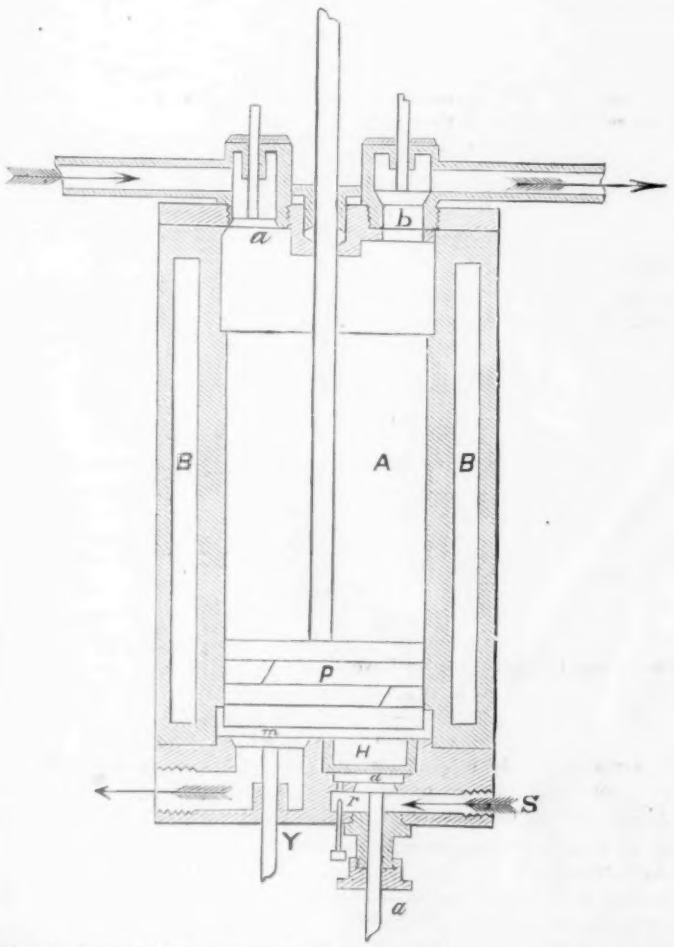


Fig. 1.—Sectional View of Cylinder of the Brayton Non-Explosive Gas Engine.

The cylinder has a water jacket, and the piston has metallic packing rings, as in the steam engine, the same method of lubrication being applicable. A diaphragm of several layers of wire gauze, similar to that of the safety lamp, is placed in the cylinder ports, in order to prevent the ignition of the gas in the reservoir. The gas charge in the cylinder is fired by a small gas

jet, as will be explained later. The reservoir containing the gas mixture is provided with a safety valve of sufficiently large area to avoid serious accident in case of explosion. If fluid hydrocarbons are used in place of gas, the reservoir is filled with pure air only, and carburization takes place between the reservoir and the cylinder.

The action of the engine is exactly similar to that of the steam engine. The mixture of gas and air is not exploded as in other gas engines, but simply burns as it flows into the cylinder; and the gas pressure, up to the point of cut-off, is as uniform as in any steam engine. In a trial of one of these engines the maximum pressure was found to be 75 pounds per square inch at the beginning of the stroke, gradually diminishing to 66 pounds at the point of cut-off, where the speed was nearly a maximum; from the point of cut-off the pressure declined, in accordance with the laws of expansion of gases. A 5-horse power engine of this style, tested at the Vienna Exhibition in 1873, developed as a maximum rather more than its rated power. The mean power, as determined by a dynamometer, was 3.986 HP, the indicated HP at that time being 8.62. The engine consumed on the average about 32.06 cubic feet of gas per dynamometrical HP per hour. It is surprising, at first, to find the great difference between the indicated and dynamometrical horse power of the engine, but when we consider that, besides the friction of the engine, some power is lost in overcoming the resistance of the compressing pump, it seems quite natural that this great difference should exist.

Figure 4 represents a sectional view of the cylinder of the engine. A is the working cylinder, surrounded by the water jacket BB, to prevent overheating. P is the piston, and as this is directly exposed to the ignited gases, it is protected by a separate plate of cast iron and a layer of asbestos. The upper end of the cylinder is used as a compressing pump, and is provided with the two valves *a* and *b*. It is obvious that as the piston descends the induction valve *a* opens and admits the gas and air into the cylinder; when the up-stroke of the piston occurs, the eduction valve *b* opens, *a* is closed, and the gases are forced into the reservoir. At the bottom of the cylinder, and below the range of the down-stroke of the piston, there is a chamber in which there are two or three diaphrams of wire gauze, kept in position by two outside plates. The partition is termed the "intercepter," because it guards the passage leading from the reservoir, and prevents the ignition of the gas mixture therein. This intercepter is so located that all the gas consumed in the engine must pass through it. The induction valve *a'* is opened for every up-stroke of the piston by means of a cam or rock shaft, thus admitting the compressed mixture of air and gas into the cylinder. A constant flame is maintained on the surface of the intercepter, by making a small aperture through the valve seat wall, its area being regulated by means of a pointed screw, *r*. The exhaust valve *m* is worked by some suitable mechanism, opening it at the proper time to admit the escape of the products of combustion.

Having thus given a general description of the engine, we will now pass over to the theory of it.

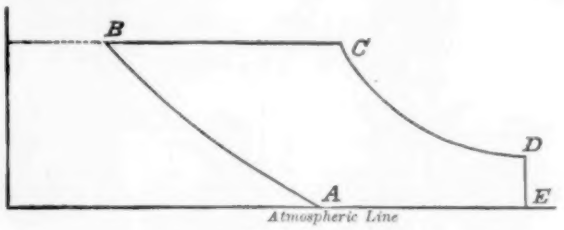


Fig. 5.

The annexed figure (fig. 5) represents an indicator diagram of the engine, AB being the curve of compression and CD the curve of expansion of the gas. Let Ta and Pa be the temperature and pressure of the atmosphere respectively, being also the temperature and pressure of the gas and air mixture as it is taken into the compressing pump; let also Pe, Te, Pd, Td, Pc, Tc, and Pb, Tb be the pressures and temperatures corresponding to the points E, D, C, and B,—Ve, Vd, Vc, and Vb being the corresponding volumes. The specific heats for constant pressure and constant volume being given respectively by the formulæ

$$Cp = \frac{.2375x + .343}{x + .48} \text{ and } Cv = \frac{.1684x + .286}{x + .48}$$

we have for the value of k, Cp ÷ Cv. Assuming the temperature Ta, we can find Tb from the equation

$$\frac{Ta}{Tb} = \frac{Pa^{(k-1)\div k}}{Pb^{(k-1)\div k}} \therefore Tb = Ta \div \frac{Pa^{(k-1)\div k}}{Pb^{(k-1)\div k}}$$

The pressure Pb, which is the pressure in the reservoir, may be assumed. The value of Vb is found from the equation

$$\frac{Va}{Vb} = \frac{Pb^{1\div k}}{Pa^{1\div k}} = \frac{1}{Vb}$$

Va being assumed to be 1 cubic foot or .0283 cubic meters.

To find the temperature Tc, we must assume or obtain experimentally the value of H_1, which is the number of meter kilogrammes developed by the combustion of one cubic meter of gas mixture. Then, if D is the density, we have

$$\frac{H_1}{JCpD} = Tc - Tb.$$

J being Joules equivalent, 424 meter kilogrammes. From this equation we obtain the value of Tc, namely,

$$Tc = \frac{H_1}{JCpD} + Tb$$

The increase of volume from B to C is effected at constant pressure, and therefore in the equation

$$\frac{PbVb}{Tb} = \frac{PcVc}{Tc}$$

Pb and Pc are equal and drop out, giving

$$\frac{Vb}{Tb} = \frac{Vc}{Tc} \therefore Vc = \frac{Vb}{Tb} \times Tc$$

Determining the value of *r*, the ratio of expansion, we can by its aid find Vd, since

$$\frac{Vd}{Vc} = r \therefore Vd = Vc \times r.$$

Also

$$\frac{Td}{Tc} = \frac{1^{k-1}}{r^{k-1}} \therefore Td = Tc \times \frac{1^{k-1}}{r^{k-1}}$$

$$\frac{Pd}{Pc} = \frac{Vd^{-k}}{Vc^{-k}} \therefore Pd = Pc\frac{Vd^{-k}}{Vc^{-k}}$$

From D the pressure falls at constant volume until the point E is reached, whence we have

$$\frac{PeVe}{Te} = \frac{PdVd}{Td} \therefore \frac{Pe}{Te} = \frac{Pd}{Td} \therefore Te = \frac{Pe}{Pd} \times Td$$

$$\frac{Pe}{Pd} \times Td = \frac{Pa}{Pd} \times Td$$

The value of H_1 is

$$H_1 = JCpD(Tc - Tb)$$

and the value of H_2, the meter kilogrammes rejected per cubic meter, is

$$H_2 = JD\,[Cv\,(Td - Te) + Cp\,(Te - Ta)\,]$$

Consequently E equals efficiency of engine, equals

$$\frac{H_1 - H_2}{H_1} = \frac{JCpD\,(Tc - Tb) - JD\,[Cv\,(Td - Te) + Cp\,(Te - Ta)\,]}{JCpD\,(Tc - Tb)}$$

The available heat per indicated horse power per hour is

$$\frac{1{,}980{,}000 \text{ ft. lbs}}{\text{efficiency.}} \quad \frac{273{,}754.8}{\text{efficiency.}} \text{ meter kilogrammes.}$$

Gas consumption for perfect efficiency is

$$\frac{273{,}754.8}{(x+1)\,H_1}$$

and dividing this by the actual efficiency, we get the actual gas consumption.

Numerical Case. — The pressure Pa, equals atmospheric pressure, equals 2116.4 lbs. per square foot, equals 10334 kilogrammes per square meter. Let Pb equal 6 atmospheres, the pressure in the reservoir of the engine; this pressure is equivalent to 62004 kilogrammes per square meter. Also assume Ta equals 15°C + 273 = 288° absolute temperature. Let the gas mixture consist of 12½ volumes of air to 1 of gas; then for Cp and Cv we have

$$Cp \text{ equals } \frac{.2375 \times 12.5 \times .343}{12.5 + .48} \text{ equals } \frac{3.312}{12.98} \text{ equals } .2551$$

$$Cv \text{ equals } \frac{.1684 \times 12.5 \times .386}{12.5 + .48} \text{ equals } \frac{2.391}{12.98} \text{ equals } .1842$$

$$k \text{ equals } \frac{Cp}{Cv} \text{ equals } \frac{.2551}{.1842} \text{ equals } 1.385\text{; therefore } k - 1 \text{ equals } .385$$

$$\frac{k-1}{k} \text{ equals } .278$$

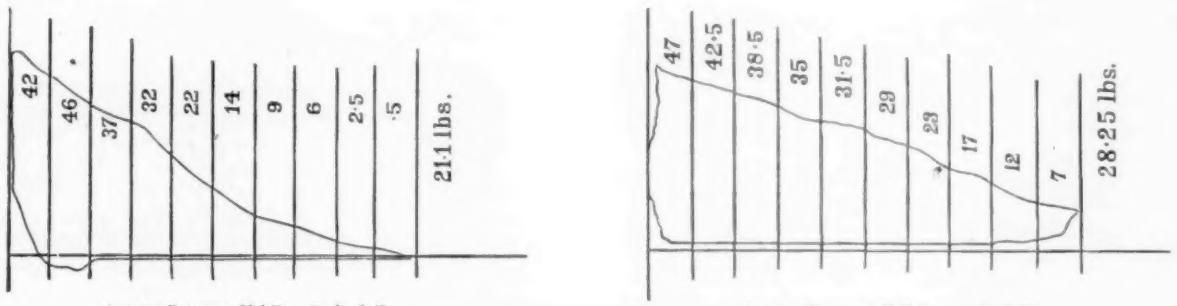
$$\frac{1}{k} \text{ equals } .722$$

With these values we can now find Tb from the equation

$$\frac{Ta}{Tb} = \frac{Pa^{(k-1)+k}}{Pb^{(k-1)+k}} = \frac{288}{Tb} = \frac{10334^{.278}}{62004^{.278}} = \frac{1^{.278}}{6^{.278}}$$

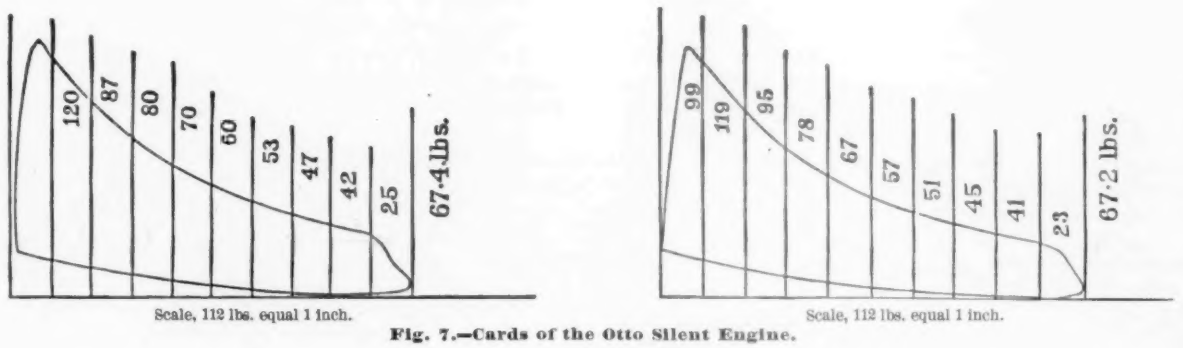
whence Tb = 458.7°. Also,

$$\frac{1}{Vb} = (6)^{.722} \therefore Vb = .0077 \text{ cubic meters.}$$



Average Pressure, 21.1 lbs. Scale, 1-48. Average Pressure, 28.25 lbs. Scale, 1-48.

Fig. 6.—Cards of the Eclipse Engine.



Scale, 112 lbs. equal 1 inch. Scale, 112 lbs. equal 1 inch.

Fig. 7.—Cards of the Otto Silent Engine.

Assuming H_1 to be 185,067.88 meter kilogrammes per cubic meter, we have

$$\frac{H_1}{JCpD} = \frac{185,067.88}{424 \times .2551xd} = Tc - Tb = 1365.4$$

Therefore Tc equals 1365.4 + 458.7 equals 1824.1°

$$\frac{Vb}{Tb} = \frac{Vc}{Tc} \therefore Vc = \frac{Vb}{Tb} \times Tc = \frac{.0077}{458.7} \times 1824.1 = .0306 \text{ cu. meters}$$

Va we know to be equal to .0283 cubic meters.

If now we assume the ratio of expansion as 3, we have

$$\frac{Vd}{Vc} = r = 3 \therefore Vd = 3 \times .0306 = .0918 \text{ cubic meters.}$$

$$\frac{Td}{Tc} = \frac{1^{k-1}}{r^{k-1}} = \frac{1^{.385}}{3^{.385}} = \frac{Td}{1824.1} \therefore Td = 1824.1 \times \frac{1^{.385}}{3^{.385}} = 1200°$$

$$\frac{Pd}{62004} = \frac{.0918^{-1.385}}{.0306^{-1.385}} \therefore Pd = 13,534.2 \text{ kilos. per sq. meter.}$$

Also,

$$Te = \frac{Pe}{Pd} \times Td = \frac{10334 \times 1200}{13534.2} = 916°$$

Pe being equal to Pa, which is the atmospheric pressure.

$H_2 = JD\,[Cv\,(Td - Te) + Cp\,(Te - Ta)\,] = 113,488.7055$ meter kilogrammes per cubic meter.

We can now get the efficiency, which is

$$\frac{H_1 - H_2}{H_1} = \frac{185,067.88 - 113,488.7055}{185,067.88} = .386$$

The available heat per I. horse power per hour is

273,754.8 ÷ .386 = 702,209 meter kilogrammes,

and the gas consumption equals

$$\frac{273,754.8}{13\frac{1}{2} \times 185,067.88} = .1098 \text{ cubic meters,}$$

providing the efficiency were perfect; since the efficiency is, however, only .386, the gas consumption is .1098 ÷ .386 = .2844 cubic meters (about 10 cubic feet.)

This is a remarkably low figure when we consider the consumption of other gas engines. Thus, the Lenoir engine consumes about 70 cubic feet per horse power per hour, and the Hugon engine about 74 cubic feet. The Otto silent engine consumes less gas than the two just given, the requisite quantity being about 17 to 18 cubic feet for large sizes (40 HP) and about 22 cubic feet for smaller sizes. Experiments were made at Dentz regarding the gas consumption of this engine, and it was found that for an engine with a 6½ inch cylinder and 12 inch stroke, about 1-40th to 1-44th of a cubic foot of gas was required for one charge, the amount varying, of course, with the quality of the gas and the work to be performed.

Since an engine of the above-mentioned dimensions develops about 5½ horse power at 160 revolutions per minute, it follows that 21 cubic feet per I. horse power per hour is an approximate consumption. This, however, does not include the consumption of the slide lights, which require about 5 cubic feet per hour.

In figures 6 and 7 the two diagrams with the regular, unbroken expansion curves are indicator diagrams obtained from an Otto silent engine, while the other two diagrams were obtained from an Eclipse engine, which, though altogether different in principle from the Otto engine, was found to consume very nearly the same quantity of gas.

Figure 8 also represents an indicator card of an Otto silent gas engine, the arrows indicating the direction of the piston. The horizontal line A is

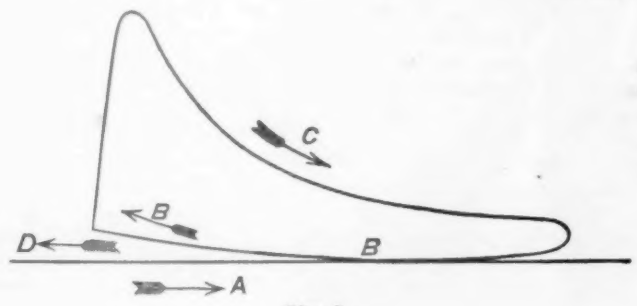


Fig. 8.

just below the atmospheric line, and represents the outward stroke of the piston (single acting), drawing in by suction a charge of gas and air. When the piston performs its back-stroke, the mixture is compressed, as shown by the compression curve BB. Having completed this

stroke, the explosive mixture is ignited, producing a rapid elevation of pressure; the piston, yielding to this pressure, moves forward, and the expansion line C is traced. Finally the piston, returning as shown by the arrow D, expels the products of combustion. This action, then, is continually repeated, and it will be observed that the engine makes two revolutions or four strokes for each individual explosion. The engine must therefore have a very heavy flywheel, the momentum of which performs three strokes out of the four. The proportion of the number of explosions for a certain number of strokes may be varied to suit the occasion, thus allowing greater economy of gas when light work only is done. We can not have more than one explosion for four strokes, but we can have more than four strokes for one explosion. Economy of gas is also secured in this engine by the greater dilution of the required gas with air, this being possible because the charge is ignited under pressure.

The principle of compression of the working fluid was first employed in Captain Ericsson's air engine, in which it served a double purpose—

1. It diminished the temperature to which the air had to be raised, and thus diminished the excessive heat so pernicious to these engines.

2. It permitted the reduction of the size of the several parts for a given power.

But if the previous compression is so advantageous in the working of the engine, it may be asked, Is it equally advantageous to its practical performance? In other words, is the advantage gained an adequate return for the work expended in compression?

Calculations show that the same quantity of gas not compressed would yield a greater amount of total motive force; but, on the other hand, the loss resulting from the compression is compensated by a better utilization of the heat generated.

Numbers of gas engines, and especially those of the Otto type, are now coming into use, and, judging by the variety of purposes to which they are applied, a great and promising future is in store for them. The prejudice of the public against them at first was probably due to the failures of the earlier engines, and to the jealousy of makers of small steam engines, who saw in them formidable rivals to their productions. Some difficulties still remain to be overcome in their construction and action, but this will not hinder their present practical utility, as is shown by the many thousands in use in different parts of the world.

Mr. R. P. Spice on Electric Light.

The following letter, written to the Directors of the Dublin Gas Company, gives the views of one of the leading gas men of England on the electric light. An effort is being made to induce the Dublin authorities to grant permission to an electric light company to lay wires, etc., the real object of which is to give the shares a good send-off and establish the electric light company in Dublin on a business basis without the trouble of going to Parliament for powers, as gas companies are obliged to do.

21 Parliament Street, Westminster, S. W.,
12th July, 1881.

To the Chairman and Directors of the Alliance Gas Co., Dublin:

Gentlemen:—I have not been unobservant of the attention paid and the encouragement afforded to the efforts made for the promotion of electric lighting in your city.

Nor have I been surprised at the effect produced thereby on the market value of the property of your company, experience having proved that public opinion is easily affected, adversely to the interests of the holders of property in gas undertakings, by the highly colored statements of the numerous advocates of the "light of the future," as it is fondly called by its patrons, which, they say, is to supersede gas as a lighting power.

But, while it is to be deplored that the holders of shares in a perfectly sound and stable undertaking, such as yours, should be deluded into parting with their interest in it at a price or prices far below its intrinsic value, the consolation remains to you, and those of your shareholders who know better than so to sacrifice their property, that, as a prosperous and good paying concern, it is worth as much as it ever has been.

I make this statement to you in all seriousness, with as full and intimate an acquaintance with the facts as regards the surroundings of the two systems of lighting as almost anyone can obtain, and without an atom of prejudice against the electric light; regarding it, indeed, with great favor, my opinion being that it is proving to be, to gas companies, a blessing in disguise.

For the past two years I have been proclaiming the doctrine, that, as people become accustomed to a light of great intensity, such as the electric light, they will find it extremely inconvenient to put up with the less powerful gas burners, such as those which the parsimony of local authorities have hitherto commonly insisted on as being sufficient for lighting the streets of cities and towns; and the truth of this doctrine has been abundantly proved by the brilliant specimens of gas lamps which have been set up in London and in the cities and large towns of the provinces.

Perhaps the best known specimens of public lighting by electricity are to be seen in the metropolis; and respecting its character and durability, it is not too much to say, public opinion is divided. Some admire it, some accord to it qualified praise, and others object that it is cold and disagreeable in character, while the intensity interferes disagreeably with the vision in passing from one intense light to another, through the comparatively obscure space which intervenes.

Then, again, another objection with which observers in general cannot fail to sympathize is the vital defect of its uncertainty. This has very often been proved most inconveniently, all the lights on a circuit having gone out again and again through some unobserved defect by which the flow of the current has been stopped, the effect being to leave the district in total darkness. This has occurred several times on the Thames Embankment, on the Holborn Viaduct, and in some of the most important streets of the city of London.

A popular falacy has lately been widely and industriously propagated, that this may be overcome by the 'storage of electricity," Sir William Thomson having had a box of it sent over to him at Glasgow all the way from Paris! Wonderful, certainly, but worth nothing practically, except for scientific purposes. Who would think of sending a box of gas from Paris to Glasgow, except to show that it could be done? And who does not know that either the one or the other, gas or electricity, can be much more economically produced where it is wanted than it can be made and stored and sent in a package from one place to another, the two places being some hundreds of miles apart?

And then, again, as to the quantity of "electric energy" sent to Glasgow being stated as amounting to "one million foot-pounds," this appears to me to be studiously delusive. The box containing this energy is said to have weighed 75 lbs., and this weight of coal is capable of giving out 12 million foot-pounds, and the boasted one million foot-pounds of electric energy means about the same quantity as is contained in two cubic feet of compressed gas.

The whole thing, indeed, practically considered, is a delusion, and has not advanced the storage of electricity one single step. We are just where we were, and nowhere else, as concerns the question of "storage."

Electricity has to be produced as it is wanted, and conducted to where it is wanted, and any trifling hitch in the combined operation will prove fatal to the continuity of the current and extinguish the lights depending upon it.

So much for the application of electricity to public lighting.

The most important experiments and display of its adaptability to the lighting of interiors have recently been made in the House of Commons; and the result, after several trials, was a failure. The character of the light was objectionable; its uncertainty was more than once made disagreeably manifest, and the old system of lighting by gas was decided to be preferable.

While these experiments were going on, another practical application of it was sought to be effected by an old established firm, having large business premises in Westminster, to which they have recently added a carpenters' shop, adapted to the requirements of sixty workmen; however, as the sum required by the Company for the requisite fittings and dynamo-electric machine was £700, the luxury of the light was abandoned, for the simple reason that the cost of driving the machine to produce the light, the expense of attendance upon its working, and wear and tear, added to the interest on the first cost of fittings, would greatly exceed the cost of gas.

This may serve you as a gauge to enable you to measure pretty accurately the chances of your business of gas supply being interfered with by electric lighting finding its way generally into interiors. And it may well encourage and restore confidence to shareholders, whose faith in the continued prosperity of gas undertakings may have been shaken by the assertions of electricians and others that "the days of gas lighting are numbered."

Possibly these days may be numbered, but no one has yet ventured to predict the number, nor can anyone determine it within a century or two. The prediction was made more than thirty years ago, when a great step in advance was effected, and the light was exhibited at the Polytechnic Institution; but although a generation has passed away since then, the prophecy remains unfulfilled, and just about as far from fulfillment as ever. Side by side with modern electric lighting in its most improved forms, the use of coal gas has gone steadily on at an accelerated rate.

It would be difficult indeed, to point to any business which has prospered so steadily through long continued seasons of depression and convulsions, which have shaken the very foundations of commerce, and never has the prosperity of gas undertakings been more solid and assured than at the present time. Nor could a better incentive to increased means of economy in production, and consequent widening of the base of this prosperity be devised than the electric light, and this will be proved as certainly in Dublin as in London.

It is cheering to know that while the zeal of some prominent electricians palpably exceeds their common sense, and has led them to make ridiculous assertions, there are others, such as Dr. Siemens and Mr. Preece whose attainments in this special branch of science are of the highest order and second to none, who have over and over again publicly declared their convictions that the use of gas will not be prejudicially interfered with by electric lighting. These foremost electrical authorities are content with widening the field of their operations, well knowing there is ample room for both; and we gas men know equally well that the more electric lighting prospers in its acknowledged proper sphere, the better it will be for that interest for the prosperity of which we are more particularly concerned.

My advice to your shareholders, therefore, is that those of them whose main object is a sound investment, steadily yielding a satisfactory income, *stick to their property*, which will certainly continue to flourish, and let those of their fellow citizens who are so minded, manifest their patriotism by taking shares in the projected "Dublin Electric Light Company," and wait patiently for the result of its operations, which may possibly teach a much needed lesson, calculated to enlighten us respecting the actual cost of the luxury, concerning which a great amount of ignorance prevails.

I am, gentlemen,
Yours faithfully,
R. P. Spice,
M.Inst. C.E., M.I.M.E., F.R.G.S.

[From the London "Journal of Gas Lighting"]

The Economics of Gas Management.

By Mr. Henry Woodall, of Leeds.

[Read at the Eighteenth Annual Meeting of the British Association of Gas Managers, held at Birmingham.]

I have long held the opinion that whatever importance may be attached to the engineering details of gas works and manufacture, or however captivating prospective improvements connected therewith, there are at the present moment, waiting our command, certain simple commercial principles, generally little observed, which, if put into full operation, would distance all other considerations in the advantages they would confer. It shall be my endeavor to put before you, in as short a space as I can, a few of the most salient features of the policy which recommends itself to me, and without daring to hope that my views will meet with general acceptance, I have no doubt that many of us will derive some advantage from the discussion.

Of two great evils which beset gas consumers—extravagant engineering and Parliament—the latter inflicts the most widespread injury; the former, in occasional instances, the most acute. Here and there, I am sure, this observation will meet with an eloquent response in the breast of a manager, whose deserts never can be appreciated, simply because the works he manages were construced by an engineer who, reckless as regards expenditure, has so heaped up the capital, that everyday economies are smothered by the burden of interest inexorably demanded. I have in my mind an instance in which the amount required to pay the statutory dividend exceeds 3s. per 1000 feet, in a locality where, upon a reasonable capital, the same rate of dividend might have been paid, and gas sold at about 2s. 6d. per 1000 feet. Now, under no ordinary conditions, as regards management or future engineering, can gas be sold at such a place at a reasonable price. About 2s. per 1000 feet has been wasted; and though the public may never know where to put the blame, it will stand as an enduring reproach to the directors under whose management such engineering was permitted.

I am strongly of opinion that, in granting a common rate of dividend upon expenditure, whether large or small, without regard to its incidence upon the price of gas, Parliament has shown a strange disregard for the consumers interests, and I should be glad if I could persuade gas managers generally that the future success of our undertakings may be in inverse proportion to the success achieved when we have induced Parliament to accede to our most ardent demands.

It is rarely that coal or any other item or group of items in our accounts influences the price of gas to the consumer so materially as the dividend; nor is there any item so difficult to move in his favor by the manager. And seeing with what certainty price and demand act and react upon each other, it should be the careful study of the manager to provide that any augmentation of plant should be accomplished, not only without swelling the amount of capital expenditure in relation to gas sold, but at a greatly reduced scale.

An ordinary rate of expenditure on capital account has been £600 per million feet of gas manufactured per annum; but at the present prices of materials it is not difficult to meet increased demands at a cost of £250 per million feet, or less than half the original expenditure. And, apart from price of materials, every year is witnessing an improvement in the situation in this respect, as I shall presently be able to show. The dividend on a capital of £600 per million feet, at an average rate of eight per cent. ,cost practically 1s. per 1000. Now, supposing extensions of plant to be effected at a cost of £250 per million feet, and that the dividend on this is limited, as is now sometimes the case, to five per cent., then upon this the cost is only 3d. per 1000 feet, and there is thus a direct saving of 9d. per thousand feet on all new business; and again, supposing an increase in the demand at the rate of 10 per cent., the price of gas may be reduced by ¼d. annually, until the charge for dividend falls to 5d. per 1000 or less.

Now, I know it will be contended that works, including mains and meters, cannot be laid down at £250 per million, for it may be shown that such a figure would only correspond to a capital of £50,000 for a make of a million feet per day in midwinter, and this may be a smaller rate of capital than exists. Well, I am not sure that works could not be constructed today within the price I have named; but supposing this were impossible, it is easy to show that for additional business my estimate is amply sufficient. Let any one consider that a million feet per annum is but the produce of one retort making 5000 cubic feet per day over a period of 200 days—the average time that a retort is in action during a year—and that consequently by every 5000 cubic feet that he improves the yield of his retort-house, he is saving capital to the extent of £40 (the cost of retorts per mouthpiece), and he will at once perceive how many ways there are in which economies of this kind may be effected. To dwell for a moment on this item, a retort house containing 100 retorts, each producing 4000 cubic feet, and afterwards improved to 5000 cubic feet, is thereby increased in value by at least £1000, and if the remaining portion of the apparatus happens to be commensurate with this larger make, then the practical saving is double this amount.

Without going through the various portions of our plant which we generally know how to exact more work from when necessity demands, I will pass on to consider the gasholders, which cost, supposing their capacity to be equal to the greatest make of 24 hours, about 30 per cent. of our total expenditure in plant. The ways in which economies may be attained on this item are various. Single-lift holders may be converted into double-lifts, or double-lifts to treble-lifts, thus saving the necessity for new land and tanks; but better still is it, in my opinion, to limit the capacity to, say, 80 per cent. of the greatest day's supply, and to endeavor to equalize the demand throughout the hours of day and night. It is the happy tendency of our business to improve in this direction. During the day gas is being used for purposes too numerous to mention, and for the night we have to thank the promoters of the electric light for having created a taste for better street illumination, from which we cannot fail to reap considerable advantage. Our energetic President, supported as he has been by the most enterprising of Corporations, has shown us a brilliant example of how to shame the best efforts of the electrician, and it only remains to show at what a nominal cost such a display can be provided.

Perhaps even superior to the better lighting of public thoroughfares, in its economic aspect, is the warming of bedrooms throughout winter nights. People are rapidly coming to appreciate the luxury and benefit to health of an equable temperature, and when it is known that this can be conferred, by means of gas fires, at the price of a glass of wine or thereabouts, we shall find that the costly disparity between the demand of one period of the 24 hours and another has been greatly diminished.

These latter observations have had reference to the saving to be effected by diminishing the ratio of holder capacity to the day's sale; for manifestly if gas were in request at a constant rate it might be sent to the consumers direct from the purifiers, and holders dispensed with altogether. And the nearer we approach this condition, the more we diminish the relative cost of plant, and the consumer derives a direct advantage by the amount of interest.

But however advantageous it may be to us to encourage the sale in winter it is clearly more profitable to improve it in summer; for while a demand which is *pro rata* throughout the year—that is to say, which necessitates the erection of new works in the old proportion—can be met, as I have endeavored to show, at a cost of 3d. per thousand feet, even this sum is saved upon all business acquired during at least 10 months which shall be in excess of the rate of increase in midwinter. Let me explain. Suppose the make of gas in midwinter to be 500,000 cubic feet, and the annual consumption 100 millions (the annual make divided by the daily make giving 200 as the quotient). Suppose again that next year you find that whilst the greatest daily make has continued at half a million, that you have increased your annual make to 110 millions—your quotient for the year having increased to 220—you have clearly manufactured ten millions which has not required any extra plant, and the saving, where interest amounts to 1s. per 1000 feet, has been £500 on the year. I have introduced the quotient here simply to recommend it to those who have not already adopted it, as a ready method of recording, by a tabular number, progression or retrogression in our business, which is extra profitable as the figure is increased. Were it not that we require in all our apparatus some margin to admit of repairs, 365 would be our perfect number, for this would show a demand uniform throughout the year, and every portion of our plant fully employed.

I need not occupy your time by dwelling upon the smaller cost of mains and services in relation to an increased sale, for it is generally understood that a quadruple capacity can be acquired only at a twofold cost, and also that to improve the supply throughout a densely populated district, it is frequently only necessary to intersect the district by a single main of large area; and thus where the original system of mains may have cost £200 per million feet, it is quite feasible to give a double supply at a rate not exceeding £50 per million feet.

I think it will be found generally that meters cost about 12 per cent. of the total expenditure in plant. Where meter rents are charged—and I consider it to be decidedly to the advantage of both buyer and seller alike that they should be charged—there is no manifest gain to a gas company upon a limiting of expenditure in this direction. But what is of equal moment to us is that the consumer profits the more, the more duty he extracts from the meter. If he burns 60,000 cubic feet of gas per annum, and his meter rent is 5s., the meter costs 1d. per 1000 feet. If he consumes double this quantity he has purchased his gas at an abatement of one halfpenny; and were he conscious of the economy he was effecting, he would be inclined to prize it at double its value, because he had secured it to himself by his unaided intelligence. And here I would predict that the day is near at hand when the manufacture of two and three-light meters will be very largely curtailed. Gas is now being used so profusely, and for such various purposes, that the smaller meters must speedily give place to larger ones in such numbers that those brought away will meet the demands of new property. I would advise managers to be very circumspect in ordering these smaller sizes, or it may shortly happen that they will find their stores encumbered with a costly stock for which there is no outlet. I confidently look forward to the 10 light meter supplanting the three-light in thousands of cases in my own town within a period of three years.

To tilt at Parliament may be about as profitable as at windmills, and far less entertaining. Nevertheless it may be well to remark upon the serious consequences which have resulted to gas consumers from the want of some guiding principle in parliamentary legislation as it affects them. One company spending at the rate of £1000 per million feet, advised by its solicitor, asks for £100,000 of original capital to bear 10 per cent. dividend, and gets it, at a cost of 2s. per 1000 feet to the consumer, and is removed beyond the pale of legislation for many years. In the same session another company, whose expenditure has been at the rate of £500 per million feet, asks for £20,000, and quickly spending it, comes again for capital, and is limited to 7 per cent., and in ten years the difference, commencing at one shilling, has improved to 1s. 2d. in favor of the consumer. Well, there recently came a time when there appeared to be a probability of consistency in legislation, when it was enacted that new shares should be put up at auction, and the premiums obtained become capital without bearing interest—an excellent system, almost as good as to have left the previous legislation alone, and simply to have limited new shares to 5 per cent. At this juncture there sprang into existence the sliding scale, which, however much it may recommend itself at first blush to gas managers and proprietors, must in the long run prejudicially affect the interests of the former, if not of both, while there can be no question as to the burden it puts upon the gas consumer.

Previously to the introduction of the auction clauses, Parliament was limiting the dividends on new capital to 6 per cent. But as premiums on ten per cent. capital generally ran as high as 100 per cent., it was evidently thought that by putting up shares at auction, capital would be raised at a charge to the consumer of only 5 per cent. Five per cent. then was considered by Parliament to be an adequate return upon gas investments. Look you now what follows. A company requiring capital applies for it under the new regulations. Its previous capital was £100,000. It needs to spend perhaps at once £10,000, 5 per cent. upon which amounts to £500, but by reducing the price of gas 4d. per 1000 feet, the company obtains the right to pay an extra one per cent., not only upon the new £10,000, but also on the original £100,000, and in this way new capital, which was denied more than 5 per cent. by Parliament, has become a charge upon the consumer to the extent of 16 per cent. Now, I say it most advisedly to every gas manager present, that this sort of thing cannot be profitable either to him or to the consumer, and in the long run it may be found prejudicial to the interests of the proprietor himself, by retarding the growth of the business, exciting cupidity, and inducing reprisals on the part of towns' authorities. I fully sympathize with the manager who, having a bill before Parliament, seeks to secure to his employers the best return he can for their investment; but let him look all the facts in the face, and I venture to think he will see that the interests of seller and buyer are one, and that Mr. Sellers, of York, when he contented himself and his company with a hard and fast 5 per cent. showed more wit than he received credit for at the time.

Having now touched upon the manner in which capital charges and rate of interest affect the price of gas, I will pass on to notice the incidence of certain charges in the revenue account. It is not my intention to occupy your time by discussing the many items in such an account severally, and so, for convenience, I will deal generally with a hypothetical case of gas at 3s. per 1000 feet.

I will assume that such a price may be divided into three, as follows—

Net cost of gas in the holder, after allowance for residuals	1s.	0d.
Distribution, including repairs of meters, mains and services, rates and taxes, collection, inspection, salaries, printing, etc.	1	0
Dividends	1	0
Total	3s.	0d.

In respect of the first section of the account, I have only to say that it does not fall within the province of this paper to deal in any way with economies in manufacture. The third section I have previously treated of. There is, however, a mine of wealth in the second section, for all of the items in the group there is scarcely one that is materially influenced by the quantity of gas supplied. Mains are laid down in the early career of a company, and ramify to the utmost limits of supply, and the maintenance of these, as also of the service pipes, costs no more whether gas flows through in a rapid stream or is stirred only by the leakage. The repairs of roadways are in relation to the mileage of mains, and are in no way affected by the sale of gas. It is as easy to take the index of a meter which has registered a million feet as if the quantity were only a hundred, and the collection of the larger account is frequently the simpler matter. Of this, too, I am positively certain, that salaries are by no means proportionate to the sale of gas. Repairs of meters, rates and taxes, office expenses, printing and stationery, are all of them items which are not affected relatively to the sale. Now, if I were to say that a doubling of the consumption would not increase the aggregate cost of this group of charges by more than 20 per cent., I should feel quite safe; but I will be liberal and allow 25 per cent. And so there accrues a saving at the rate of 9d. per 1000 feet again, which, together with the previous saving of 9d. on capital, makes 1s. 6d. per 1000 feet on newly-acquired business. I have said nothing hitherto about leakage, which to many minds I know to be of vital consequence. Leakage I regard as being affected almost wholly by the length of mains and their condition, *plus* the adverse difference in the registration of meters, and hardly at all by the quantity of gas flowing through them. The gain, therefore, under this head, by doubling the consumption where the present ratio is 10 per cent., would be 5 per cent., which, taking the value of gas in the holder at 1s., would result in a saving of a little more than ¼d. per 1000 feet. However, I will not take this item into account, and will only deal with the figure I have previously named—*i.e.*, 1s. 6d. Now, the question is how to make the best of our opportunities in regard to this large advantage. If we wait until the business doubles in the regular way, years go by, and the abatements we can make are small and unappreciated; the price, too, being high, competition is encouraged. If we divide the gains over all consumers alike, irrespective of profitable consumption, we give to the many at the cost of a few, and we limit the possibilities of our business in like proportion.

The incidence of commercial charges will form the subject of a paper by Mr. Warner, and therefore I will not dwell upon this part of my subject, but will give an illustration of the mode in which we can apply the advantage I have endeavored to show that we possess. There is a competition in progress between electricity and gas for public lighting. The cost of gas is reckoned at its present market price. Electricity gives a more powerful light, which the vendors do not fail to take cognizance of when making their comparisons. It is only by so doing that they can hope to compete. Now, seeing at what a nominal price an extra quantity of gas can be made, and delivered to the public lamps, why should not the company say to the lighting authority: "If you want additional light, and will enter into a contract to consume a double supply of gas, we will charge you for the extra quantity at half the price you pay for your present consumption?" The gain by such an arrangement would be mutual, and it would only be securing to the lighting authorities the advantages they would be fairly entitled to. There can be no doubt that if all classes of custom were expanded to the extent I have indicated, the price, where uniform, would be uniformly reduced. If, therefore, one section of our consumers, clearly defined as are the lighting authorities, show a disposition to increase their demand, it is but rational, to my mind, that they should receive at once the fullest advantage we can concede. For my own part, I should rejoice to see the consumption of gas in the public lamps of Leeds increased from 3½ to 5 cubic feet per hour, at a charge for the additional quantity not exceeding 1s. per 1000 feet. It is desirable, and in most instances absolutely necessary, that advances should be commenced with public lighting, for it is a common provision in our Acts of Parliament that the price of gas supplied to public lamps shall be not higher than the lowest price charged to any consumer. At present the public lamps certainly are not our best customers, but an additional supply thereto may be sold under most advantageous conditions, and in my own locality I have no hesitation in saying that 1s. per thousand

feet on the extra supply would yield a higher rate of profit than our present business taken in the gross.

What the possibilities of gas lighting are may perhaps best be explained by putting my own experience briefly in the concrete form. In 1876 the sale in Leeds amounted, in round numbers, to 800 millions, and the income from gas alone to £150,000. In 1881 the sale is 1200 millions, and the income £120,000; so that a favorable combination of circumstances has resulted in 400 millions of feet being given away, and £30,000 a year with it. Let it be granted that there is now an end to the special conditions under which these results were obtained, still I think I have shown that we have ample grounds for pursuing our business with large handed enterprise. I trust also that it will be quite patent that the electric light has really to compete with gas at less than half its present price, and also that schemes for supplying two qualities of gas through separate systems of mains can only result in disaster if ever carried into practice. To adjust the price to the consumption, or to vary it with the character of the business, is not quite so easy in any other case as in that I have offered as an illustration of the working of the principles I am advocating; but as time goes on, and new markets present themselves, the difficulties of the situation will no doubt prove to be more apparent than real.

I dare not trespass upon your time to pass in review the host of minor considerations which fall within the range of my subject—such as meter-rents, discounts and differential charges, deposits, methods and times of collection, trading, advertising, etc. These I shall be happy to deal with another time.

I have little doubt some present may be disposed to think that, in my earnestness on behalf of the gas consumer I have forgotten that I am a gas manager. This, however, is far from being the case. I am proud of the office I hold, but I look for a much greater future for our industry than I could have anticipated only a few years ago. When I tell you that the increased manufacture of gas at Leeds, for the year just ending, approaches 140 millions, or 11 per cent., you will, I think, agree with me that the low price is likely to tax the best energies of the management; and though I say it, who have perhaps less reason to speak hopefully than many another, I still say that such development of our business must inevitably result in an improvement of the status of our profession.

London Water Supply.

The recent hot weather in London made a severe demand on the various water companies that supply the city, and, in addition to the heat, at the very time when everything was most pressed to meet the demands, a large main pipe burst in one of the districts, which caused much inconvenience and a deficiency of supply.

We publish the following letter as valuable mainly to show just what the supply of water is in London—

To the Editor of the Times:

Sir—Having been officially concerned for many years with the management of an important portion of the London water supply, and having thereby acquired a practical knowledge of the whole question, yet having now no direct interest in the matter, we should like to say a few words at the present moment upon what has been designated as the recent metropolitan "water famine."

That something defective exists with regard to the water supply of the metropolis is evident, otherwise no such deficiency as that lately experienced in certain districts would be possible.

Unhappily, defects in other matters affecting the metropolis are not far to seek. Notwithstanding a plethora of food, we have instances of starvation in our midst, and we have had evidence recently that the fish supply of London, while abundant, is yet extremely scarce. So, with the supply of water to London—while myriads of millions of gallons have been constantly running away over the weirs of the river Thames, householders have been complaining of great deficiency in the water supply. It may, then, be worth while to expend a few minutes in endeavoring to ascertain what this defect really is and who is responsible for it.

The question naturally divides itself into two heads—viz., the supply of water into London and its distribution after arrival. On the subject of supply it has been assumed that some neglect or insufficiency of pumping power has existed on the part of some of the metropolitan water companies. Let us, therefore, first inquire if this assumption is based upon fact.

If we refer to the Water Examiners's (Colonel Bolton) reports for the year ending June 30, 1881, we arrive at the fact that during that year the average daily supply of the whole water companies has been 145,732,116 gallons. But this figure, of course, includes hot weather and cold, drought and losses of water in frost time (the latter a very heavy item, etc.) For the present purpose it will be simpler to compare the gross amount of the daily supply as reported in the above return for the month of December last with the recent quantity pumped into London during the so-called "water famine." The return for last December shows that the daily supply to London during that month was 134,710,844 gallons, while during the month of June, 1881, the supply reached 162,305,736 gallons, showing an increase in the daily supply of 27,594,892 gallons. During three weeks of the month of July (when the three elements of drought, heat and the acme of a London season were all united, and it required the greatest exertions to be made on the part of the companies to meet the wants of the public in their excess) the supply increased to no less than 172,326,135 gallons, or an excess over and above the December supply of 37,616,135 gallons daily, and of 25,407,191 gallons above the average daily supply in June, 1880.

Now, what do the above figures represent as regards the individual house supplies of the metropolis? The total number of houses supplied in December last was 601,210, so that the water supply of 134,710,844 gallons is equivalent to an average daily supply per house of 225 gallons. But in the month of June last the number of houses had increased to 609,847, and the gross supply to 162,305,736 gallons or an average daily supply per house (large and small) of 266 gallons.

With particular companies, those, for instance, at the West-end of London, where the largest and most fashionable houses are to be found, where the most extravagant use and waste of water exist, and where, moreover, from the general absence of factories, etc., nearly the whole of the supply is used for domestic purposes, the average per house is greatly in excess of the above figures, and in the Grand Junction and in the Chelsea Companies' districts has amounted to 328 gallons per house per day. The return for the present month of July, when published, will show, of course, a still higher figure—certainly during the very hottest of the weather, on two days of which one of the West-end companies had increased its supply from an average 12,000,000 gallons daily to 17,771,640 gallons on the 19th, and 17,985,290 gallons on the 20th of July, representing a consumption of upwards of 45 gallons per head per diem, or two and a-half times the quantity agreed by eminent experts to be necessary. Yet this is what in popular language is termed a water famine.

Years ago, when Mr. Edwin Chadwick was president of the Board of Health, he published some sensible and very strong remarks upon the extravagant waste of water in London houses, and he took the trouble, with reference to a considerable group of houses of a good class in the western part of London, to gauge the quantity of water flowing into the houses and flowing out again during the same period into the drains and sewers. The result of this experiment was that he ascertained that no less than 50 per cent. of the supply was carried away in the form of direct waste during the time of service.

The fact is, that the Parliamentary powers of the company as to house visitations for regulation of fittings and prevention of waste, backed up by no outside authority, cannot be efficiently carried out without at once creating an outcry of "arbitrary conduct," of "domestic espionage," of "interference with the Englishman's castle," etc. Things must, therefore, take their course until a Metropolitan water authority is created, but whether this authority be in the form of a trust, or a commission, or a municipality, it must be armed with sufficient power to act vigorously in the organization of domestic and other water supplies, and *nolens volens* will be compelled to exert its authority stringently, in order that by systematic regulation and restriction the entire population may realize the full advantages of the supply, and no one be allowed, as at present, to prejudice his neighbor's water rights by abusing his own. This is somewhat different to the popular belief that the individual householders will have that full and unlimited control over their own supplies, which under the existing arrangements they make such strenuous efforts to obtain; for it is evident that, without proper precautions to prevent the enormous waste, neither 160 millions, nor 180 millions, nor any other number of millions of gallons of water poured into London will constitute a satisfactory supply, and that, in the midst of a glut of water, individual householders will suffer from occasional "water famine."

The public have, indeed, yet to learn that not only the suppliers, but also the recipients of the water have essential duties to perform in connection with the supply; but, until the control is placed in the hands of a public authority, this will neither be understood nor appreciated to its full extent. The good time when London is to have the full control of its own water supply is, indeed, so long in coming that it is a case of hope deferred with the usual sequence.

In justice, however, to the present water companies, it should be remembered that throughout a long series of years they have by great ingenuity and talent and perseverance (and in the earlier time by heavy and unremunerative outlay) first created and then continuously improved the means of supplying this enormous city, containing now upwards of four and a-half millions of inhabitants, with water.

That such a responsibility should have been left to private enterprise is now admitted to have been a grave error, but it is not too late to remedy it,

and in the interest of all concerned it is to be hoped that legislation in this important subject will no longer be delayed. The recent accident to the main of the Grand Junction Company, which resulted in so much inconvenience to their tenants, affords an apt illustration of the disadvantage of the present system, and *a fortiori* the advantages which would result from unity of management and amalgamation of the various companies' works; for under the latter arrangement connection could be made between the various works, and the mains of one district would be available for the supply of any other in cases of emergency.

We are, Sir, your obedient servants,

JOSEPH QUICK & SON.

29, Great George-street, Westminster, S.W.

—London *Times*.

The Petroleum Outlook.

The tables of statistics which we present this month show a decided falling off in the production of the wells; also in the number of wells drilling and rigs building. At this time last year throughout the whole northern field there was a marked activity displayed in drilling new wells and erecting rigs, which is now seen only in a limited way, and in a limited territory.

In July last year there were 452 wells drilling and 431 rigs building, against 379 now drilling, and 376 rigs building; shewing 128 wells less progressing than at the same time last year.

In July last year there were 13,275 producing wells with a daily average production of 5¼ barrels per well; now there are 17,000 with a daily average of 4.7 barrels per well; showing that as the number of wells increase, their average production decreases in about the same ratio.

The stock of crude oil held in the producing region has been increasing in the last eighteen months prior to the month of June at the rate of about one million barrels per month, or nearly one-half of its production; during the month of June the shipments were very large, which absorbed a large amount of the surplus stock at the wells, leaving 648,163 barrels, or only about one-fourth of the production to go into stock; in July the shipments were much larger than in June, which made a still larger draft on well stock, leaving a surplus of only 447,146 barrels, or about one fifth of the production.—Stowell's *Petroleum Reporter*.

The Channel Tunnel.

At a meeting of the proprietors of the South-Eastern Railway, held on the 16th of August, Sir Edward Watkin, M.P., the chairman, described the experimental works which had been undertaken, with the view to show whether the making of a tunnel under the Channel between England and France was feasible and practicable.

The whole question he said divided itself into two parts. One was whether they could pass under the Channel through a stratum which was impervious to water. The second point was whether, by the aid of machinery, they could shorten very considerably the probable time of construction. What they had done was this—

They had already sunk two shafts on this side of the Channel; one at the Abbot's Cliff Tunnel, and the other on this side of the Shakspere Cliff Tunnel. From the first of these shafts they had driven a gallery of from 800 to 900 yards, of a diameter of seven feet, which had all been excavated by machinery. Last week, with that machinery, which was not perfect, they excavated 67 yards of lineal distance on the extension of that gallery. If that were the maximum speed each week, it meant about two miles of progress a year. Of course, as they worked from two ends, and as the distance was only twenty miles, practically speaking, it meant five years to complete a gallery seven feet in diameter, as an experiment, under the whole length of the Channel.

As to the second shaft, at the Shakspere Cliff, they had sunk that down to a depth of 155 feet. They had also bored from the bottom of the shaft to a further depth of 106 feet. They had found no trace whatever of water in the old grey chalk. There was a small quantity of water near the surface, but this is always expected. He therefore thought that solved the great questions of the speed at which they could go, and of the impermeability of the strata to the leakage of water.

On the other side of the Channel the French company had sunk two very important shafts, and they had found exactly the same results as had been ascertained on this side. As to the machinery, they were on the eve of concluding another arrangement with Captain English, Colonel Beaumont, and M. Figou, the proprietors of the machine with which they had been working. Under this new arrangement, they would pay merely for the use of the machine, and by means of it they would carry those experiments considerably further.

It had been arranged between the French and English committees that they should drive through a heading of a further length of one mile on each side. When these two miles were finished—and they certainly ought to be in six months—one tenth of the question was dealt with. If that were successful he should, he thought, propose a further treaty with the French gentlemen under which the remaining nine miles on each side would be done, and they would meet in the middle of the Channel. If that were successful, the whole question was practically settled.

Until the matter was proved, however, neither the French nor the British investor would be asked to embark capital in the undertaking. The South-Eastern shareholders were, as it were, the founders of the feast. They had taken all the risk, and they had authorized an expenditure of not more than £20,000 upon the affair. Now, a great deal of what they wanted to prove had been proved.

He meant to ask them to consider how best to make what had been proved more positive, and then to consider whether they should not get up a small limited liability company, or other company, to take the matter in hand, without further interfering with the finances of the South-Eastern Company.

This was a question deserving serious consideration at their hands. They must, however, never forget that it was absolutely essential that this tunnel matter should remain under South Eastern control.—*Van Nostrand's*.

Brick Foundations for Machinery.

Experiments and observations concerning the strength and utility of brick foundations for machinery have been summarized by the age of industry. Trautwine is quoted as saying that a rather soft brick will crush under a weight of 450 to 600 pounds per square inch, or about 30 to 40 tons per square foot, while a first-rate machine-pressed brick will require from 300 to 400 tons per square foot. This last is about the crushing limit of the best sandstone—two-thirds as much as the best granites or roofing slates. But masses of brickwork, he notes, will crush under much smaller loads than single bricks.

In some English experiments, referred to by this author, small cubical masses only nine inches on each ledge, laid in cement, crushed under 27 to 40 tons per square foot. Others with piers nine inches square and two feet four inches in height, in cement, only two days after being built, required 44 to 62 tons per square foot to crush them. Another, of pressed brick, in best Portland cement, is said to have withstood 202 tons per square foot, and with common lime mortar only one-fourth as much.

The same authority is careful to add, however, the statement that cracking and splitting usually commence under about one-half the crushing loads. To be safe, he recommends that the loads should not exceed one-eighth or one-tenth of the crushing load, and so also with stone. Moreover, he notes these experiments were made with low masses, but the strength decreases as the proportion of the height to the thickness increases. He cites the following example—

The pressure of a brick shot-tower in Baltimore, 246 feet high, is estimated at six and a-half tons per square foot; and in a brick chimney at Glasgow, Scotland, 468 feet high, at nine tons.

Professor Rankin calculates that in heavy gales this pressure is increased to fifteen tons on the leeward side. The walls of both are, of course, much thicker at the bottom than at top.

With walls of 100 feet high, of uniform thickness, the pressure at the base would be five and four-tenths tons per square foot. He prudently concludes that with our present imperfect knowledge on this subject, it cannot be considered safe to expose even first-class pressed brickwork, in cement, to more than twelve or fifteen tons per square foot, and good hand-moulded bricks to more than two thirds as much.—*Sci. Press*.

An Improved Ammoniacal Manure.

A company has just been formed with objects which will probably be of great interest to gas manufacturers. Lieut-Col. Bolton and Prof. Wanklyn working in conjunction with several well-known gas engineers, Mr. F. W. Hartley among the number, have for some time past been engaged at the South Metropolitan gas company's works in perfecting a process for the economical recovery of ammonia from crude gas, in the form of a solid manure or fertilizing agent. The process, which is patented, and of which the details will shortly be made known, is reported to be remarkably simple, and is intended to be applied in the course of the ordinary operations of the purifying-house, without special plant. Washing and scrubbing will, it is expected, be done away with in the new process, a considerable saving in plant being thus effected, in addition to which a common source of loss of illuminating power, due to the absorption of hydrocarbons in the scrubbers will be avoided. The ammonia will be fixed in a dry form, sulphate of ammonia being procured, together with phosphate of lime, in its best state,

THE AMERICAN GAS LIGHT JOURNAL

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FRIDAY, SEPTEMBER 2, 1881.

Official Report of Examinations of Gas for three Weeks ending Aug. 20, 1881, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

1881. Aug	Time of Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
		†	*	†	‡	*	†
1		24 24	19.09	26.76	24.21	18.30	29.20
2	Between	26.48	——	27.38	23.70	18.56	29.46
3	9.30 A.M.	26.97	18.03	28.82	23.76	18.83	29.61
4	and	28.20	17.81	27.28	24.25	18.74	29.76
5	1 P. M.	26.68	19.57	28.39	24.07	18.53	29.32
6		27.15	19.23	27.83	23.96	18.73	29.14
	Average	26.78	18.74	27.41	23.99	18.61	29.41
8		24.70	19.44	27.87	23.92	17.72	28.30
9		——	17.87	27.87	23.64	20.82	29.17
10		23.55	17.58	26.24	24.37	19.97	28.54
11		25.74	17.53	25.70	——	18.97	28.14
12		23.10	19.26	27.30	23.28	18.79	30.09
13		22.77	18.90	24.30	23.92	18.92	28.51
	Average	23.97	18.42	26 54	23.82	19.20	28.80
15		24.98	18.51	24.40	24.82	19.52	29.60
16		26.71	18.10	25.36	23.63	19.48	29.13
17		25.61	18.08	26.87	23.34	18.08	29.04
18		25.48	17.41	24.78	23.52	20.07	28.32
19		28.82	19.01	22 47	24.29	18.90	28.00
20		26.64	18.16	24.45	23.25	19.80	29.90
	Average	26.37	18.21	24.72	23.81	19.31	28.99

* Five foot lava tip with check.
† Bray's slit union, No. 7.
‡ Bray's slit union, No. 6.

E. G. LOVE, Gas Examiner.

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
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SEPTEMBER 2, 1881.

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☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid.	Asked
Gas Co.'s of N. Y. City.				
Central	$166,000	50	60	65
Harlem	1,800,000	50	88	90
" Bonds	170,000			103
Manhattan	4,000,000	50	210	215
Metropolitan	2,500,000	100	150	152x
" Scrip	1,000,000	..	105	109
Mutual	5,000,000	100	69	70
" Bonds, go'd.	900,000	1000	100	104
Municipal	1,500,000	100	185	190
" Bonds	750,000		106	110
New York	4,000,000	100	105	106
Northern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	125	127
Citizens	1,200,000	20	53	56
" S. F. Bonds.	320,000	1000	100	105
Fulton Municipal	1,500,000	100	70	75
Peoples	1,000,000	10	35	40
" Bonds	290,000	.	101	104
" "	250,000	...	70	75
Metropolitan	1,000,000	100	60	65
Nassau	1,000,000	25	62	64
" Ctfs.	700,000	1000	95	100
Williamsburgh	1,000,000	50	63	67
" Bonds		...	98	103
" Bonds	40,000	—	—	—
Richmond Co., S. I.	300,000	...	70	75
Out of Town Gas Companies.				
Buffalo Mutual, N.Y	750,000	100	72	76
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	85	90
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	——
Cincinnati G. & C. Co.			178	180
Consolidated, Balt.			58	60
Bonds			137	——
East Boston, Mass		25	114	120
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	140	144
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	255,000	40	117½	
Jersey City	750,000	25	155	160
Jacksonville, Ill	120,000	50	100	...
Lewistown Maine	400,000	100	—	100
Laclede St Louis Mo	1,200,000	100	108	110
Montreal, Canada	2,000,000	100	153	154
New Haven, Conn		25	132	——
Oakland, Cal			32	33
Peoples, Jersey City		...	95	100
" " Bds.				5
Pittsfield, Mass			120	130

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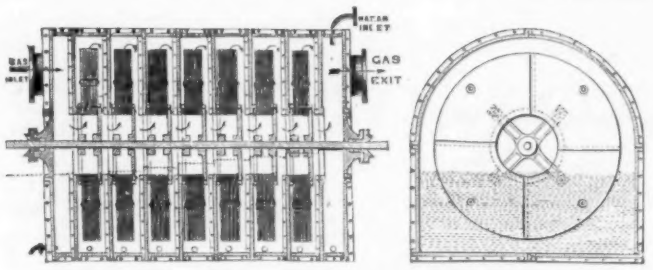

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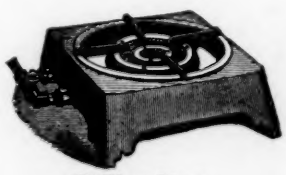

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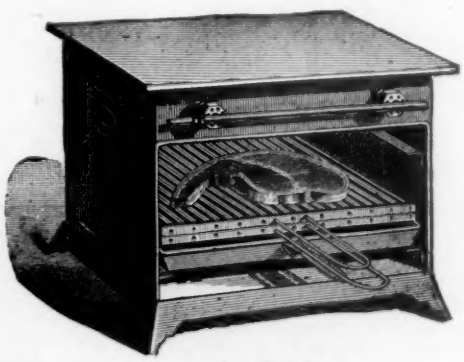

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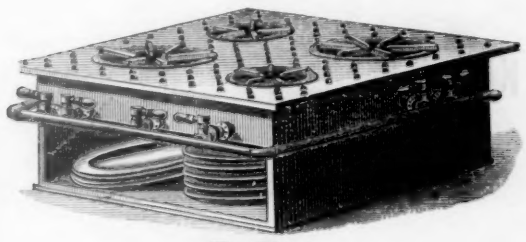

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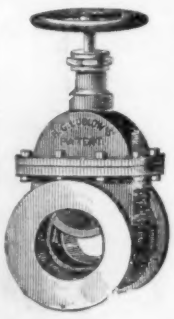

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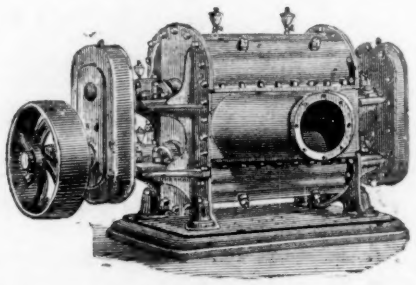

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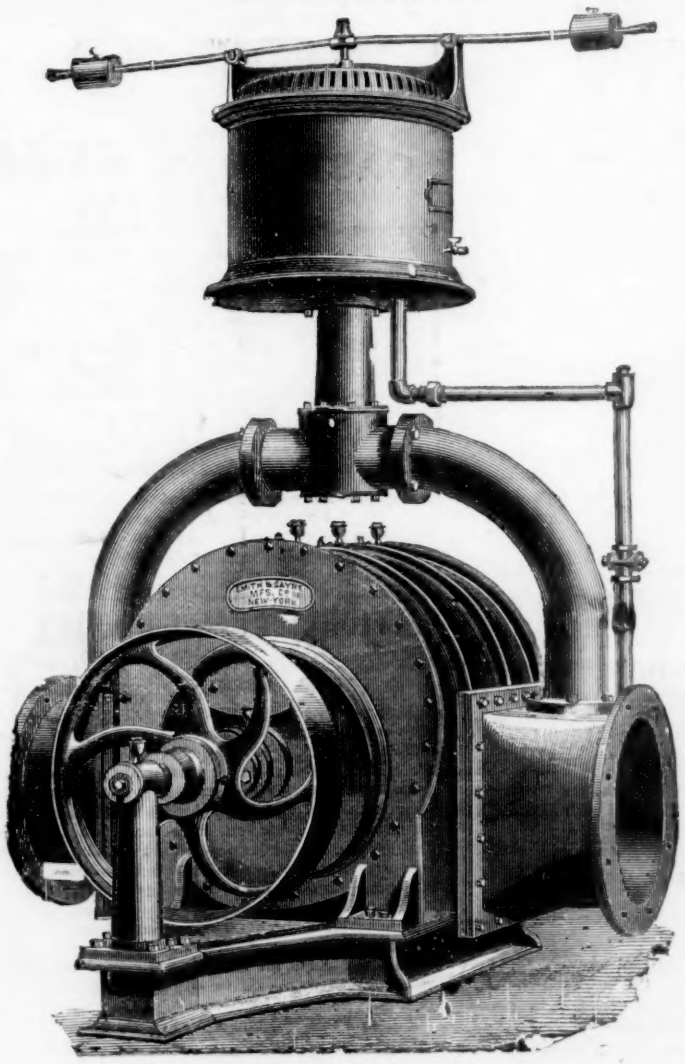

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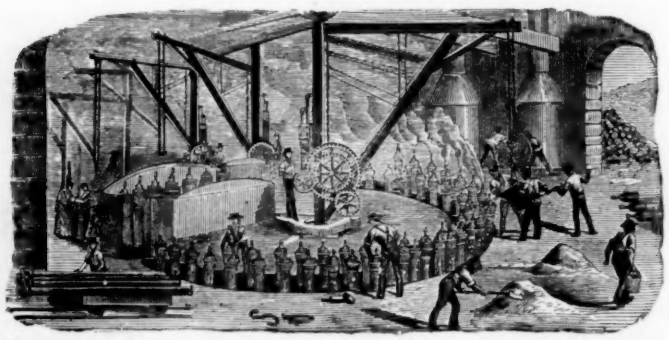

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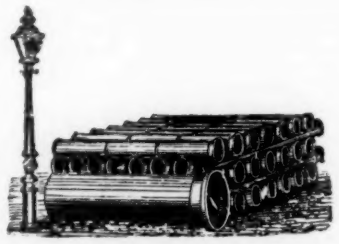

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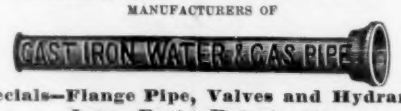

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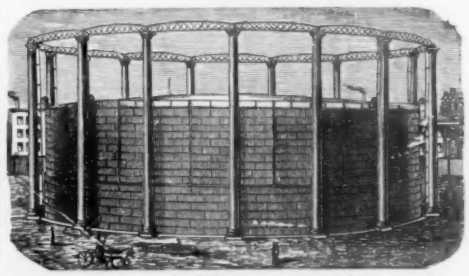

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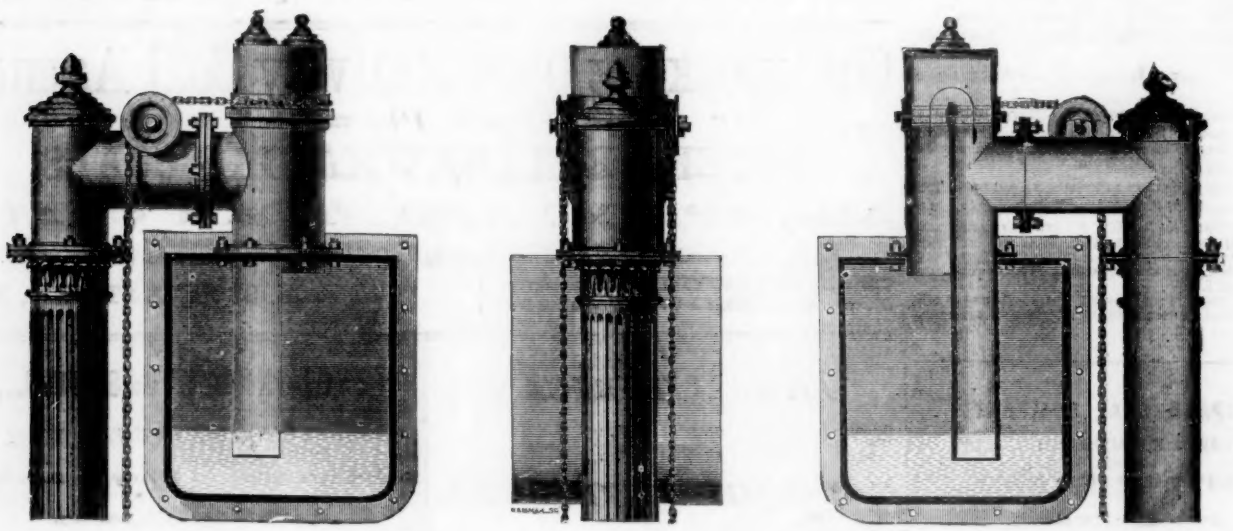

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